High-Contrast Imaging Testbed

Key Technologies Addressed

Wavefront Sensing and Control, High Actuator Density Deformable mirror, Stability of the point spread function. End-to-end system testbeds, modeling, and simulation

Objectives

The High-Contrast Imaging Testbed (HCIT) is an adaptable testbed located at JPL, established to validate the high-contrast coronagraphic technology fundamental to direct detection of extrasolar planets from a spaceborne observatory. This facility is modular, allowing for integration of modules from a variety of sources, and designed for remote observing, so that users from many institutions can be supported. JPL will schedule and support guest users commencing in FY2004.

Approach

Empirical investigation/validation of core coronagraph technology is practical with HCIT. This testbed represents two essential subsystems of a hyper-contrast instrument: wavefront retrieval and correction, and coronagraphic control of diffracted light. The testbed will validate that an instrument can achieve and maintain contrast beyond 10^{-10} at the required inner working distance of the TPF coronagraph telescope. This constitutes a fundamental confirmation that phase errors can be sensed, corrected, and held for the time period of extrasolar planet detection. Furthermore, it will validate software and diffraction models necessary to construct and operate a flight instrument. The HCIT development will consist of the following hardware thrusts: continued improvement in the deformable mirror and its performance; continued demonstration of wavefront sensing and control; and testing of apodizing masks and Lyot stops provided by government, industry, and academic sources. The testbed has been designed to accommodate a suitable subscale telescope and associated masks/stops such as are planned to be developed as part of the Industry Coronagraph Technology thrust. It could be mated with a telescope containing the Technology Demonstration Mirror although considerable additional development and modification would be required beyond the currently planned scope. In addition, the HCIT can be used to correlate analyses provided by outside sources, and can accommodate possible additional back-end subsystems

Scope

- Deformable Mirror
  - Understand and improve performance
  - Improve robustness of fabrication
- HCIT system performance
  - Improve straylight performance through baffling
  - Incorporate testing of masks and stops and other components
  - Correlate performance with model predictions
  - Demonstrate performance through a variety of environmental conditions

Current State of the Art TRL 3

The testbed is in operation and has achieved contrasts of 10^{-5}.

	Milestones	Performance Targets	TRL
2003	Initiate experiments in vacuum environment with improved DM, Apodizing masks, and stray light control	Demonstrate starlight suppression to $>10^{-6}$ contrast at $\sim 0.6 < \lambda < 0.9$ µm at $<4\lambda/D$	3
2004	Complete vacuum environment tests continued improvement in DM technology, control of diffracted and stray light, and improved masks and stops	Demonstrate starlight suppression to $>10^{-7}$ contrast for $\sim 0.6 < \lambda < 0.9$ µm at $<4\lambda/D$	4
2005	Complete additional vacuum environment experiments using continually improved components. Test components from outside sources. Understand thermal impacts.	Demonstrate starlight suppression to $<10^{-8}$ with alternative optical elements (stops, masks, deformable mirrors) at $<4\lambda/D$	5
2006	Continue improving components with mask technology development and testing components from outside sources	Demonstrate starlight suppression to $<10^{-9}$ contrast for $\sim 0.6 < \lambda < 0.9$ µm at $<4\lambda/D$	5